Usability of Biometrics for Border Crossing Introduction

- ***Usability:***
  - ***"People who use the product can do so quickly and easily to accomplish their own task"***

  => System must be ergonomic, easy to use, easy to remember, fast, comfortable, efficient, fault tolerant, …

- ***Very important for many applications (not only biometrics)***
  - ***Many factors at stake*** *(some of which subjective and psychological …)*
  - ***Especially for non habituated users and unattended systems (kiosks)***

⇒ ***Very important for biometric systems***
  - ***Impacts accuracy, speed/throughput, user satisfaction***
  - ***Traditionally biometric solutions have relied on supervision, procedures, training, …***
  - ***But it is not possible for all applications, especially those unattended and with non habituated users***
    - ***Typically the case for automated border crossing***

Jean-Christophe.Fondeur@morpho.com

Usability of Biometrics for Border Crossing
Example 1: Fingerprint (Pegase, France)

1 Airport, 2 Gates
~ 10,000 PAX Enrolled
~ 55,000 PAX verified

Token:

Dedicated SmartCard

<u>Typical performance (1:1)</u>

- Biometric reject ~ 0.6%
  (FAR~10^{-3})
- Crossing time ~ 15 s

Jean-Christophe.Fondeur@morpho.com

Usability of Biometrics for Border Crossing
Example 2: Facial (SmartGate, Australia)

2 Airports, 6 Gates
~ 40,000 PAX verified

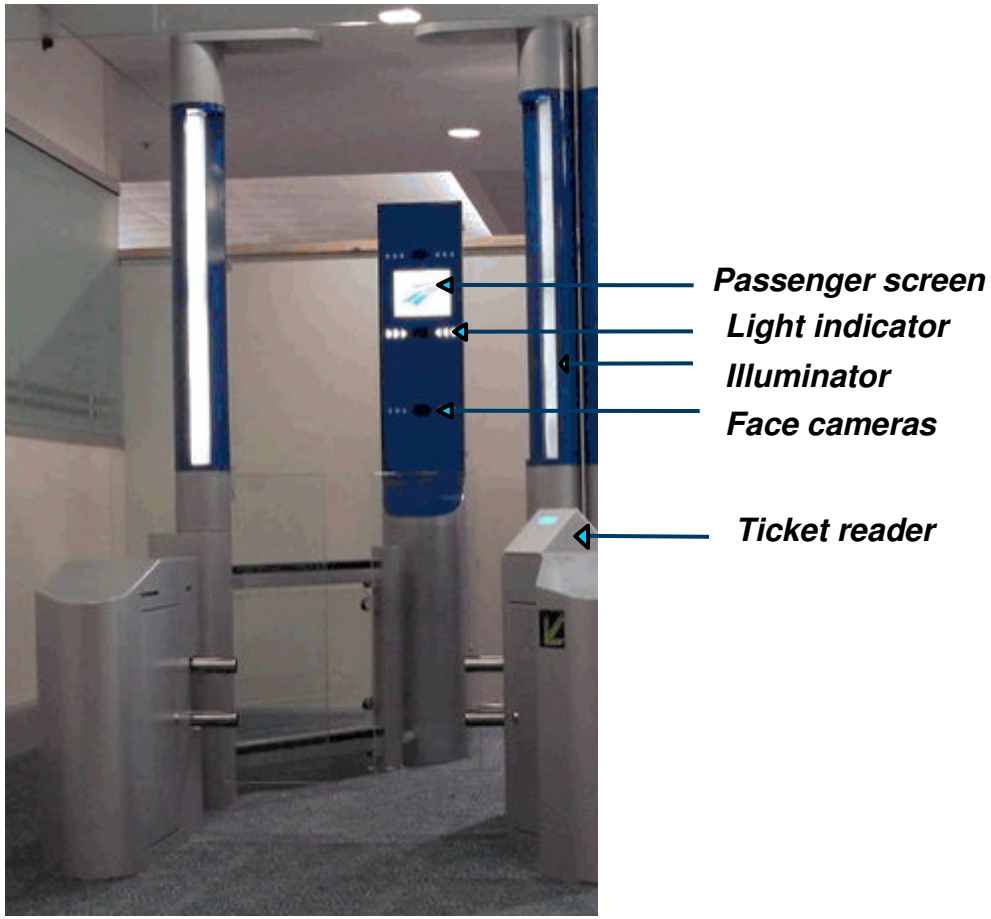
Token:

ICAO e-Passport

(no dedicated enrolment)

<u>Typical performance (1:1)</u>

- Biometric reject ~ 2%
  (FAR~10^{-3})
- Crossing time ~ 15 s



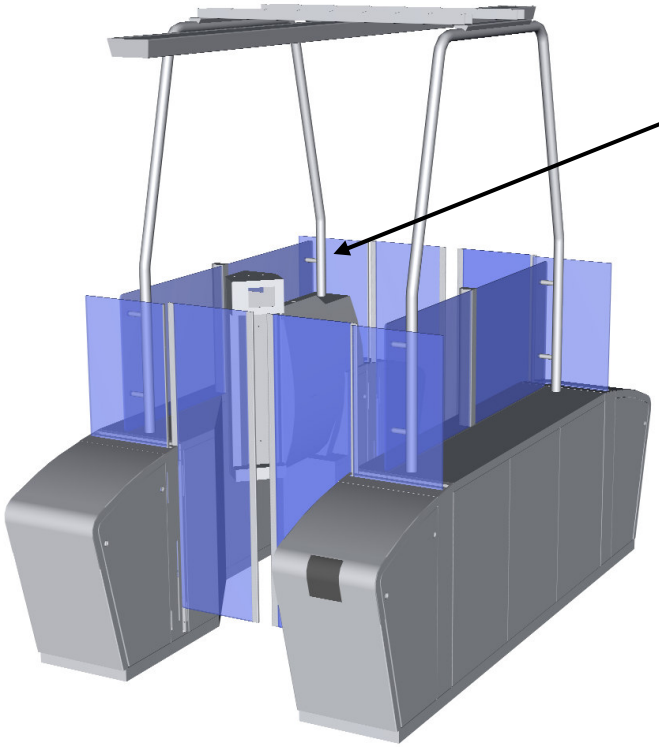
Jean-Christophe.Fondeur@morpho.com

Usability of Biometrics for Border Crossing
Example 3: Iris (IRIS, UK)

4 Airports, 12 Gates
~ 200,000 PAX Enrolled
~ 1,000,000 PAX verified

No Token:

The whole database is searched each time



Typical performance (1:N)

- Biometric reject ~ 0.6% (FAR~10^{-6})
- Crossing time ~ 15 s

Jean-Christophe.Fondeur@morpho.com

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Usability of Biometrics for Border Crossing Accommodate Various Height

- ***Need to accommodate a population with different characteristics***
  - ***Various height, various ages*** *(e.g. children)****, disabled*** *(e.g. wheelchair)*

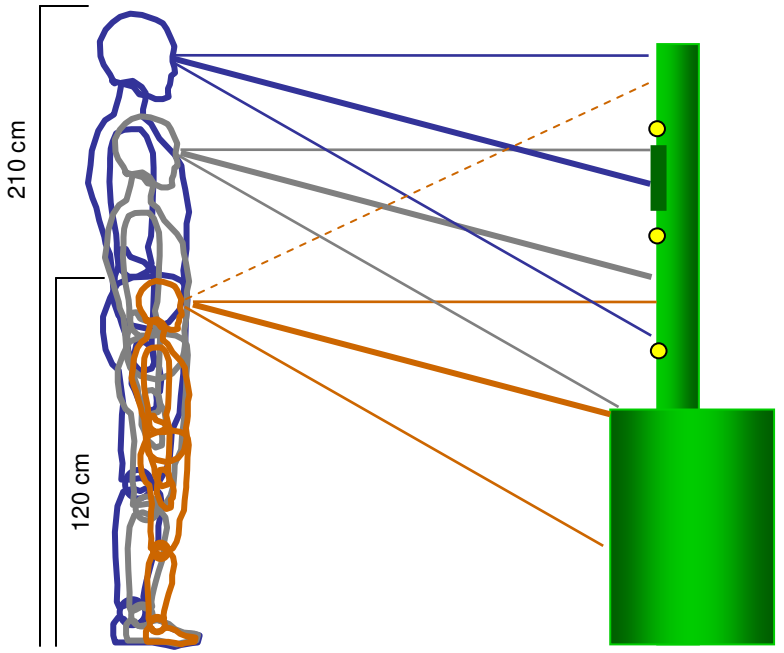
- ***Several possible designs***
  - ***Ideally, one sensor capable to deal with whole population***
  - ***Alternative options:***
    - ***Multiple device***
      - ***Selection of device to use can be automated or manual***
    - ***Adaptive device***
      - ***Adaptation can be automated or performed by user***
  - ***Choice of the solution impacts ergonomics, comfort, speed and performance***

Jean-Christophe.Fondeur@morpho.com

Usability of Biometrics for Border Crossing Accommodate Various Height

- ***SmartGate (Facial):***
  - *Requirement: 120 – 210 cm*
  - *Solution implemented (2007):*
    - *3 cameras, no "a priori" choice*
    - *Auto-capture picks up the "best quality" image*
  - *Easy to use, efficient*

- ***Pegase (Fingerprint)***
  - *Requirement: "Adult population"*
  - *Solution implemented (2005):*
    - *one sensor adjusted for average person*
  - *Pro: Simple to use*
  - *Con: not fully optimized for very tall or small people*



Usability of Biometrics for Border Crossing Accommodate Various Height

- ***IRIS:***
  - *Requirement: 120-200 cm and access to users in wheelchair*
    No single iris camera met this requirement in 2005
  - *Solution implemented (2005):*
    - ***3 camera. Choice of camera determined by user's height. User then needs to adjust with body position***
  - *Pro: meets the requirement, no need to touch the camera to adjust to height*
  - *Con: Might be uncomfortable for some people with "limited agility" especially when the wrong camera is selected (about 1% of the cases, but this 1% is very visible …)*

Validation campaigns

• 100+ people

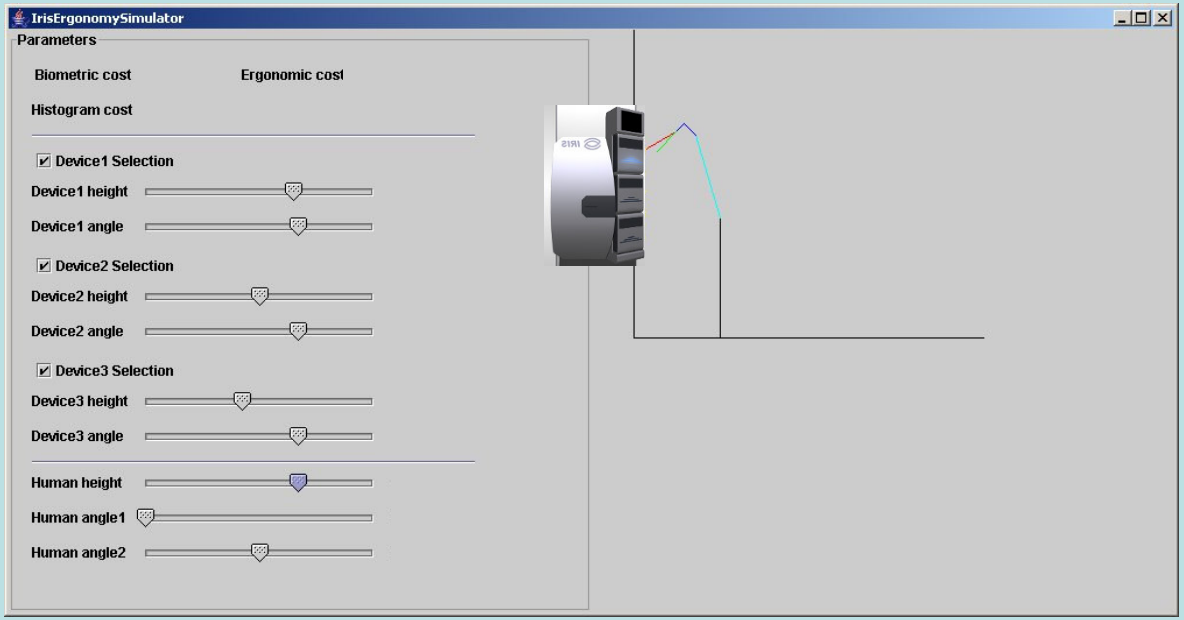
Simulation and Optimization

• Simple model of human body

•«Comfort cost» = distance from natural position

•«Biometric cost» = distance from optimal position for iris capture

⇒Optimization for a given distribution of height and users in wheelchair



Jean-Christophe.Fondeur@morpho.com

Usability of Biometrics for Border Crossing
Interaction with user, feedback

- ***Start:*** *The user needs to know when to start the capture*
  - ***Voice guidance, flashing arrows, lights (on or around the sensor)***
- ***End:*** *The user needs to know the capture is completed*
  - ***Beep, Green/Red Lights, Action (door open, print ticket, …), voice ("Thank you")***
- ***During the acquisition:***
  - *Necessary for most system to help/guide people when "they do not know what to do"*
  - ***Conscious feedback***
    - ***Vocal feedback is language dependent and slow but can be used in addition to other feedback***
    - ***Pictograms: very cultural dependant and not adapted to complex real-time feedback ("move back", "press harder")***
  - ***Unconscious (preferred)***
    - ***Attract attention, suggest best position: Video screen, light, beep, flow***
    - ***Display on screen to suggest action***
    - ***Real time feedback is very important***

Jean-Christophe.Fondeur@morpho.com

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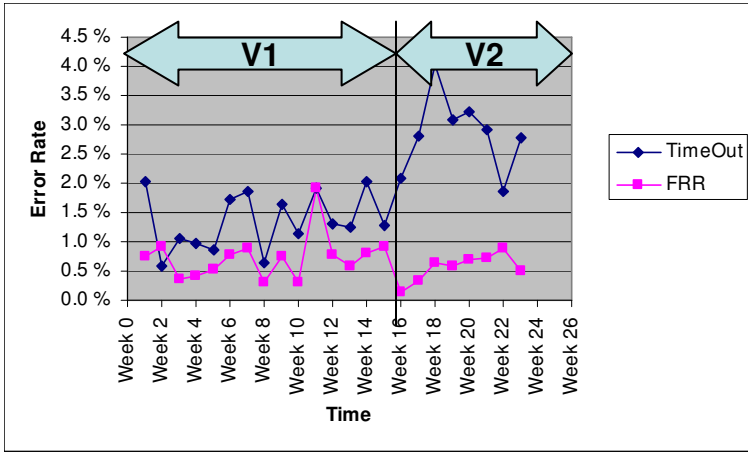
Usability of Biometrics for Border Crossing
Interaction with user, feedback

- ***SmartGate (Facial)***
  - ***Start:*** *lights to attract attention, display animation on screen*
  - ***End:*** *Green light, doors open*
  - ***During:*** *No specific guidance. Auto-capture picks up the "best quality" image*

- ***Pegase (Fingerprint)***
  - ***V1: "Initial system":***
    - ***Start:*** *Light on fingerprint sensor, instruction on screen*
    - ***End:*** *Beep, Display on screen, doors open*
    - ***During:*** *no visual feedback*



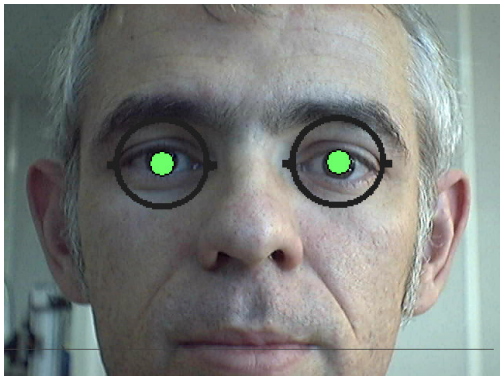
  - ***V2: "Improved system":***
    - ***Add live display of fingerprint during capture***
    - ***Remove Beep at the end of acquisition***
    - ***Change in sensor package***
    - ⇒ ***No effect on biometric reject rate***
      - ***We were expecting accuracy improvement from live display***
    - ⇒ ***Increase of the number of time out***
      - ***Some people confused by change in booth setting can be confusing ?***
      - ***Some people looking at the screen and not at the fingerprint scanner ?***
      - ***Other ?***

Jean-Christophe.Fondeur@morpho.com

Usability of Biometrics for Border Crossing
Interaction with user, feedback

- **Iris:**
  - **We wanted a feedback mechanism**
    - Easy to remember
    - Providing full guidance (x,y,z)
  - **Test:**
    - Different sensors: fully automated, semi automated (auto-focus), …
    - Different feedback mechanisms: Voice guidance, pictograms, lights, mirrors, …
    - ⇒ **"Digital miror" added in front of the iris camera to provide guidance to the user**
  - **Validation campaign**
    - In lab: 100-200 people
    - Field campaigns: 167 people enrolled and verified on a market in Africa
      - Untrained and non habituated users with no technological background
    - ⇒ **Unattended use of iris was quite impossible -at the time- without additional feedback and is possible with additional feedback**
  - **Solution implemented:**
    - **Start: Vocal "Look into the mirror" + guidance on screen + light on the selected sensor**
    - **End: Vocal: "Thank you for you cooperation" + Green arrow over the exit door, doors open**
    - **During:** "Digital Mirror" to facilitate positioning

⇒ **More than 1,000,000 successful passenger identifications**



Jean-Christophe.Fondeur@morpho.com

Usability of Biometrics for Border Crossing Performance and Accuracy

- **Uneasy to use certainly implies inefficient …**
  … but easy to use does not necessarily imply efficient

- **Design must provide both convenience and performance …**
  … but sometimes a trade off must be found
  - **If the system is too constraining, the accuracy will not be good.**
  - **If the system is too permissive, accuracy will not be good either**

- **Typical examples of such a trade off:**
  - **Auto-capture (self triggered image capture based on real time quality control loop)**
    - **Fast capture provides better user's experience but may lead to non optimal image quality**
    - **Unconstrained positioning is more convenient but may lead to non optimal image quality**
  - **Capture at a distance.**
    - **Iris capture at distance is possible and very convenient but it can be at the expense of image quality**
  - **Special procedures help accuracy, at expense of user convenience**
    - **Iris: remove glasses, hold eye wide open, …**
    - **Fingerprint: use cream or pad to improve contrast**

  ⇒ **"Optimal" decision depends on each application**

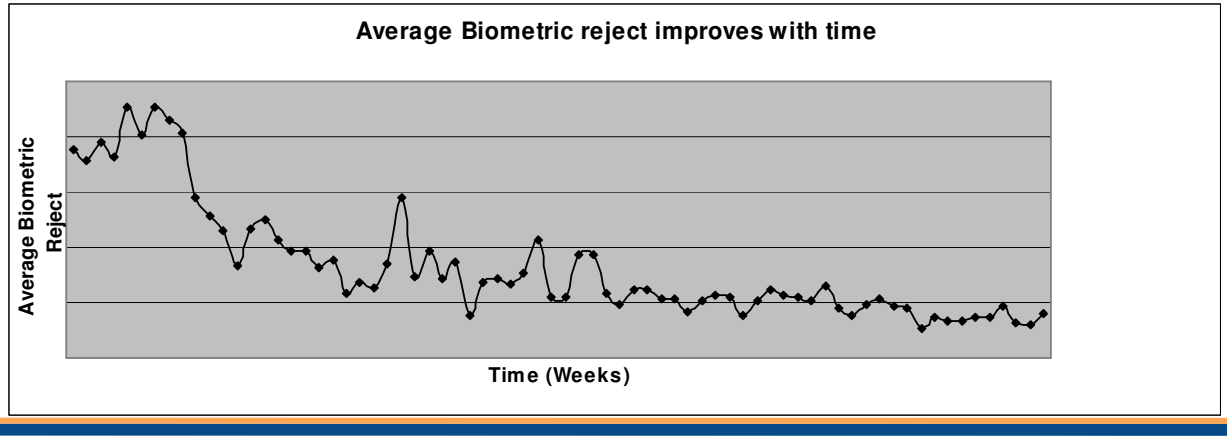
Jean-Christophe.Fondeur@morpho.com

Usability of Biometrics for Border Crossing
Training and habituation

- **Training and regular use increase the user's interaction with the system**
  - **Improved interaction between user and system (learning curve)**
  - **Improved user's confidence and satisfaction in the system**

- **Some training can generally be done at the end of "enrollment" process**
  - **Done in IRIS (training on the enroll system) and Pegase (dedicated training kiosk in the enrollment room)**
  - **Very efficient at improving user's efficiency with system,**
  - **Very positive user feedback**

- **Habituation**
  - **In average, 6 to 7 verification per enrolled user in IRIS and Pegase**



Jean-Christophe.Fondeur@morpho.com

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Usability of Biometrics for Border Crossing Conclusions

- **Usability of biometrics for automated gates is difficult**

- **Operational implementations provide useful feedback**
  - **The system must adapt to the user as much as possible**
    (rather than asking/training the user to adapt to the system)
  - **Necessity to accommodate with "non perfect" user:**
    - **Multiple attempts before rejecting the user, time out not too short, …**
  - **Necessity to simulate, but also prototype and do validation campaigns**
  - **Necessity to involve specialists (ergonomists) early in the design**

- **Lack of commonly accepted methods, metrics or guidelines to measure "usability" in the context of biometrics**
  - **Such method must measure user's convenience as well as performance (accuracy)**
  - **Could be used to validate system implementations for a dedicated application**
  - **Could also be used to study and qualify new sensor technology**
    - **Iris: Capture at a distance / on the move**
    - **Face: 3D capture, multi spectral (Visible / NIR)**
    - **Fingerprint: contactless, multi spectral, 3D, swipe sensors, …**

Jean-Christophe.Fondeur@morpho.com